July 31, 2001

Ms. Magalie Roman Salas, Secretary
Federal Communications Commission
The Portals, TW-A325
445 12th Street, S.W.
Washington, D.C. 20554

Re: Ex Parte Notification – WT Docket No. 00-32

Dear Ms. Salas:

Attached is a document entitled "4.9 GHz Allocation to Public Safety:
Motorola White Paper for Submission to FCC" that addresses a number of key issues relating to the allocation of spectrum at 4.9 GHz in WT Docket No. 00-32.

Motorola urges the Commission to issue a decision allocating this 50 MHz of spectrum at 4.94-4.99 GHz to public safety without further delay. The record in this proceeding provides ample information from public safety representatives on how such a decision would be in the public interest. We also believe that the additional information provided in this paper, combined with the Commission's experience, fully supports the adoption of technical and service rules concurrent with the allocation decision. We urge the Commission to reach such decisions without further delay to enable broadband technology providers and applications developers to start planning and engineering broadband public safety solutions. Public safety users have expressed a critical need for these solutions to meet their mission critical broadband communications needs and efficiently serve the public they protect.

Please contact John Lyons at (202) 371-6936 regarding any questions concerning this matter.

Respectfully Submitted,

John Lyons

John Lyons
Motorola, Inc.

Attachment

# 4.9 GHz Allocation to Public Safety:
# Motorola White Paper for Submission to FCC

## *July 31, 2001*

## I. Executive Summary

In WT Docket No. 00-32, the FCC proposed to allocate and establish licensing and service rules for the band 4940-4990 MHz (4.9 GHz band), a band that was transferred from the Federal Government to the private sector pursuant to the Omnibus Budget Reconciliation Act of 1993 ("OBRA").[1] The Secretary of Commerce was required by OBRA to identify at least 200 MHz of spectrum to be transferred to the private sector, all of which had to be located below 5 GHz. In February 1995, the Secretary of Commerce released a Final Report that identified the 4635-4685 MHz band for reallocation. Subsequently, NTIA substituted the 4940-4990 MHz band for the 4635–4685 MHz band.[2] The Commission proposed in WT Docket No. 00-32 to license the 4.9 GHz band for fixed and mobile services under Part 27 of the Commission's Rules and to employ competitive bidding under Part 1 of the Rules for the distribution of licenses.

In response to the Commission's proposal, over 100 major public safety organizations, associations and individual agencies have filed comments, replies and ex parte comments. These filings recommend that the Commission allocate the entire 50 MHz of spectrum in the 4.9 GHz band to public safety, rather than auctioning this spectrum to the highest bidder. These public safety filings note the requirement for the 4.9 GHz band to support broadband communications systems and describe many of the applications for which the spectrum is needed. These parties also reference the Public Safety Wireless Advisory Committee (PSWAC) report from September 1996 which documented the requirement for 97.5 MHz of additional spectrum to meet mission critical communications needs through the year 2010.[3] That report included a specific recommendation that the 50 MHz of spectrum in the 4635-4685 MHz band be allocated for public safety. As noted above, the 4.9 GHz band has since been substituted for that 4.6 GHz band spectrum.

Public safety entities noted that the new 700 MHz public safety band will be extremely useful for wide area voice and moderate speed data applications. However, they also indicated that the 700 MHz band does not have nearly enough capacity and bandwidth to support both those wide area needs and even broader bandwidth multimedia localized communications needed at an incident scene. Further, public safety commenters pointed out that the 4.9 GHz band has propagation characteristics that are ideal for short range

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1 Omnibus Budget Reconciliation Act of 1993, Pub. L. No. 103-66, 107 Stat. 312 (1993).

2 *See* Letter to the Honorable William E. Kennard, Chairman, Federal Communications Commission, from Larry Irving, the Assistant Secretary for Communications, United States Department of Commerce, released Mar. 30, 1999 ("*Reallocation Letter*") at ¶¶ 84-89.

3 To date the Commission has allocated 24 MHz of additional spectrum toward that overall requirement.

on-scene transmissions. Finally, these commenters point out that allocation of this band would allow them to leverage the standards based commercial technologies in the adjacent 5 GHz unlicensed bands into a more protected spectrum environment that offers reliability and assures the safety of their officers and first responders. In turn, all the citizens served by the nations' police, fire and emergency medical responders would benefit from such an allocation.

Many of the public safety users identified specific mission critical applications that they envision for their dedicated 4.9 GHz broadband systems. A full summary of these applications is addressed in Sections II and III of this document. Commenters detailed broadband applications that they noted as becoming essential law enforcement and first responder tools in the 21st century. These agencies and associations related such applications specifically to their functional missions, including police, fire, SWAT/tactical units, bomb technicians, hazardous materials cleanup and passenger rescue incidents. These broadband applications can generally be categorized in three groups of broadband solutions:

(1) Personal Area Network/Vehicular Area Network (PAN/VAN) systems provide solutions similar to those being developed for consumers, but specifically designed for public safety's specific needs. PAN and VAN systems provide a wireless, hands-free link between a portable or mobile transceiver and numerous devices such as headsets, portable computing devices, video cameras/thermal imagers, sensors and 3D locators, often integrated into specialized helmets and suits, enabling very localized teaming and coverage around an officer or vehicle.

(2) Wireless Local Area Network (WLAN) on-scene/incident command systems provide a very high capacity communications link to cover the immediate incident scene with real time multimedia wireless broadband communications. This enables simultaneous duplex voice, high speed data and full motion video transfers between team members and on-scene command center personnel and mobile computers.

(3) Wireless fixed "hot spot" locations provide automatic high-speed public safety Intranet file downloading and uploading of very large data, image and video files at predetermined locations, providing critical information transfer to/from public safety vehicular computers in the immediate vicinity of the hot spot transceiver.

Based on the user input in this proceeding and on our experience in serving the public safety market, Motorola identified and analyzed an example of a major on-scene incident scenario to assess the spectrum required to support these broadband operations. The example is that of a large building fire. This scenario is representative. Other scenarios, e.g., a swat scene, would involve similar overall communications capacity requirements. In the fire scene scenario, multiple fire, police and emergency medical personnel would be present. Our analysis uses the engineering approach similar to that deployed by the Public Safety Wireless Advisory Committee (PSWAC) to calculate spectrum amounts required. As detailed in Section IV of this paper, Motorola's analysis supports the public safety recommendation that the entire 50 MHz of spectrum in the 4940-4990 MHz band be allocated for public safety broadband use.

The actual usability of the 4.9 GHz band is determined in part by adjacent Federal operations just below the 4.94-4.99 GHz band, regardless of the Commission's ultimate allocation decision. US Navy CEC Systems occupy several hundred megahertz of spectrum in the bands directly below 4940 MHz. Operation is primarily in and around approximately a dozen training areas and test locations across the country but also extends outside these training areas.

The public safety community and federal users will need to work together to limit the impact of Federal operations on the 4.94-4.99 GHz band being reallocated. The common appreciation for mission critical operations that public safety and the military share forms a much better basis for coordination than would exist if the spectrum were allocated to general consumer use. Also, we believe that public safety and the military share an appreciation of the operational need to protect sensitive information appropriately and they each have personnel who are or could be qualified under the appropriate clearances. Finally, to be effective, general consumer use of this band would likely require much greater accommodation by the military, as such use is by its nature much less controlled than public safety use.

Fortunately, NTIA has confirmed that a 50 MHz guardband below 4.94 GHz and some power limitations will be used to ensure that U.S. Navy CEC system emissions are maintained at low spurious levels within the 4.94-4.99 GHz band.[4] As this commitment from NTIA appears to apply only to Navy operations outside of the designated training areas, there are still some major cities in which operations inside the training areas may impact public safety operations for some distance outside the training areas. Therefore, military – public safety coordination will be needed to provide for full use of the 50 MHz of spectrum being reallocated. Motorola conducted potential emission and desense interference analysis of the impact from adjacent band Federal systems. Our analysis considers various power levels and distances from CEC transmitters and their potential interference on public safety broadband systems. Section VI of this document summarizes the conclusions and tradeoffs which result from this analysis.

Motorola reviewed the operational needs expressed by public safety users to develop our recommendations for rules, including a channel plan and power limits. Our recommendations herein consider that public safety users must have sufficient power and sufficient bandwidth capacity to provide reliable instantaneous mission critical in-building coverage at an incident scene. Our recommendations also take into account that public safety users want to help lower costs by leveraging consumer broadband semiconductor technologies such as those used for HiperLAN2 or the IEEE 802.11 family of standards. Recommendations are contained in section VII of this document.

We are also aware of the need to protect radio astronomy operations above 4990 MHz from harmful interference. Given the relatively few number of adjacent radio astronomy sites, we recommend that frequency coordination methods be used to avoid any interference to radio astronomy from broadband public safety operations. Specifically, such coordination requirements would be triggered for public safety use within 50 miles of the current radio astronomy sites. Coordination would then be conducted to ensure

[4] See letter from William T. Hatch at NTIA to Bruce Franca at FCC, dated March 13, 2001.

that public safety broadband signals do not exceed specified limits at the actual radio astronomy site. This issue is addressed more fully in Section VIII of this document.

Finally, Motorola urges the Commission to issue a decision allocating this 50 MHz of spectrum at 4.94-4.99 GHz to public safety without further delay. The record in this proceeding is full of information from public safety representatives on how such a decision would be in the public interest. We also believe that the additional information provided in this paper, combined with the Commission's experience, yields sufficient information to adopt technical and service rules concurrent with the allocation decision. We urge the Commission to reach such decisions without further delay to enable broadband technology providers and applications developers to start planning and engineering broadband solutions. Public safety users have expressed a critical need for these solutions to meet their mission critical broadband communications needs and efficiently serve the public they protect.

## II. Public Safety Need for Broadband Spectrum

As determined by a search of the Commission's web site, more than 100 major public safety organizations, associations and individual agencies, representing various sizes and types of agencies and levels of government, have submitted comments and ex parte filings to date, urging the Commission to allocate the 50 MHz of spectrum in 4940-4990 MHz to public safety to meet their wireless broadband needs. Among the public safety organizations and associations who have filed are the International Association of Chiefs of Police (IACP), the Major City Chiefs Association (MCC), the Major County Sheriffs' Association (MSCA), the Association of Public Safety Communications Officials, International (APCO), the National Association of Black Law Enforcement Executives (NOBLE), the Hispanic American Police Command Officers Association (HAPCOA), the National Tactical Officers Association (NTOA), the National Public Safety Telecommunications Council (NPSTC), and federal law enforcement organizations such as the Public Safety Wireless Network (PSWN) and the Federal Law Enforcement Wireless Users Group (FLEWUG).

Further, individual letters from cities or city agencies now exceed 95 filings. These respondents include 34 members of the Major Cities Chiefs Association - representing this country's largest metropolitan police departments. Further, about 20% of the public safety comments were submitted by fire agencies or joint police and fire agencies. See Appendix A for the list of organizations, associations, public safety agencies and industry that have filed comments to date to the Commission on WT Docket No. 00-32 supporting a public safety allocation.

Many of the public safety entities that filed cited the broadband need first identified by the Public Safety Wireless Advisory Committee (PSWAC) five years ago. In 1993, Congress required the FCC to complete a study of current and future spectrum needs of the US public safety community through the year 2010, and develop a specific plan to ensure that adequate frequencies are made available to public safety licensees. The FCC, together with the NTIA, chartered PSWAC in June 1995 to provide advice on the specific wireless communications requirements of public safety agencies through the year 2010

and make recommendations for meeting those needs. The membership of PSWAC totaled over 480 participants representing a broad range of state, local and federal public safety agency officials, public and commercial service providers, and manufacturers. The PSWAC Steering Committee included senior officials from the FBI, Department of Defense, Department of the Treasury, New York City, Los Angeles County, IACP, APCO, Ericsson, and Motorola.

In September 1996, PSWAC issued its report to the FCC which concluded that the public safety community requires 97.5 MHz of additional spectrum allocations to meet its mission critical wireless communications needs: 2.5 MHz is needed immediately for interoperability, 25 MHz is needed in the short term (by end of 2001), and an additional 70 MHz is needed by 2010. This need is driven in the short term by voice and rapidly growing data communications. However, the greatest need for additional spectrum over the next ten years will be for advanced wideband and broadband technologies.[5]

As the users documented their needs in PSWAC, and as they indicated in their comments, new emerging broadband technologies make it critical for public safety to be able to access these solutions. Future wireless communications solutions in the new 21st Century are going beyond traditional narrowband voice and low speed data systems, and even beyond moderate speed wide area wideband systems. The Memphis Police Department shared that their three-year short range and five-year long range technology plan includes extensive use of Wireless Local Area Networks (WLAN) using, preferably, broadband wireless technologies to deploy mobile offices, mobile data terminals, handheld computers, video cameras and other computerized peripherals and technologies. They plan to deploy applications that require large amounts of data and image files to be transmitted and received wirelessly.[6]

Public safety commenters surmised that broadband commercial applications such as Bluetooth and WLANs in unlicensed spectrum will not be robust enough to be viably deployed for their mission critical operations. Therefore, though public safety users are interested in public safety variations of the broadband applications that the general public and enterprise users will be enjoying in unlicensed spectrum, they need dedicated broadband spectrum to guarantee reliability and meet their unique requirements. The San Diego Chief of Police, among others, noted that it is critical that they have dedicated spectrum and systems that assure the safety of their police officers via immediate priority access, uninterrupted transmissions, security and guaranteed coverage and liability.[7]

Several commenters also noted that there is currently no spectrum allocated to public safety to allow public safety users to implement emerging broadband technologies for their mission critical needs. IACP stated that while extremely useful for many voice and moderate speed data applications, the 700 MHz band simply does not have the capacity to also provide the very high speed, broadband public safety applications that will become essential law enforcement tools in the 21st century.[8] As summarized by NOBLE

[5] Public Safety Wireless Advisory Committee (PSWAC) Final Report, dated September 11, 1966
[6] The City of Memphis Police filing dated May 9, 2001
[7] The City of San Diego Chief of Police filing dated April 16, 2001
[8] The International Association of Chiefs of Police (IACP) Reply Comments dated May 17, 2000

and others, there are emerging broadband technologies and applications appearing on the horizon that will require significantly wider bandwidths than this allocation.[9]

As part of their argument, APCO pointed out that 4.9 GHz is better suited than the 700 MHz band for many of the advanced on-site public safety applications for two significant reasons. First, the 50 MHz of available spectrum at 4.9 GHz is better equipped to accommodate high speed, broadband transmissions. Second, the propagation characteristics of the 4.9 GHz are more suitable for short distance transmissions. In the 700 MHz band, in contrast, is better suited for wide area mobile communications that utilize relatively narrowband transmissions. In light of the propagation characteristics for the 700 MHz band, attempting to use this band for high speed broadband data transmission over short distances would be highly inefficient, and would leave public safety with inadequate spectrum to meet more immediate voice and narrowband data requirements.[10] In addition, the Denver Police Chief, along with a number of others, noted that the proximity of the unlicensed 5 GHz band to the proposed public safety 4.9 GHz allocation would allow public safety to leverage commercially developed broadband technologies and yet have the dedicated, reliable, secure and enhanced featured broadband solutions that they require.[11]

Public safety users in their comments to the Commission have expressed their desire and need to implement new advanced broadband, as well as wideband, technologies. As highlighted by the Bexar County Sheriff, over the next several years, as broadband technologies and applications develop, his office along with other County and City public safety agencies will begin to integrate these robust applications with the overall intent of improving service, reducing officer safety issues and making the patrol car a direct extension of the office environment.[12]

## III. Broadband Applications for Public Safety

Based on the comments and filings submitted by the major public safety organizations and individual agencies to date, the following broadband applications have been specifically identified for public safety uses of 4.9 GHz spectrum:

1. Police applications

   Police associations and agencies that identified broadband applications included variations of the following uses as critical to their mission in 21st Century law enforcement. HAPCOA noted that new broadband wireless applications are on the horizon, which include full motion integrated real time video and high speed data networks for on-scene command centers, high speed large file data downloads and uploads at specific "hot spot" locations, and wireless personal area networks and vehicular area networks for short range wireless networking of radios, accessories and video/imaging cameras on the officer and around the vehicle.[13]

[9] The National Organization of Black Law Enforcement Executives (NOBLE) filing dated April 17, 2001
[10] The Association of Public-Safety Communications Officials-International, Inc. (APCO) Comments dated April 26, 2000
[11] The City and County of Denver Chief of Police filing dated April 16, 2001
[12] Brexar County, Texas, Sheriff filing dated April 20, 2001
[13] Hispanic American Police Command Officers Association (HAPCOA) filing dated April 20, 2001

As noted by several police agencies, broadband applications such as personal area networks (PAN) and vehicular area networks (VAN) can wirelessly integrate a variety of existing and future devices to provide a safer environment for our officers. These include image and video cameras and viewers, mobile data terminals and all their peripheral devices, palmtops, and wireless long-range headsets, microphones, earpieces and voice recognition to allow complete hands free operation.[14]

The WLAN applications were also cited as a primary use of broadband solutions by numerous police agencies. Very large data and image files can be rapidly and wirelessly transferred within WLANs, enabling images/fingerprints of wanted or missing persons, video clips of robberies, maps and layouts to be downloaded into police vehicle mobile computers as they leave the precinct. This same technology will also allow wireless uploads of videos, images and reports from the police vehicle to the command center or precinct. WLAN technology will also enable command centers to employ full motion video for remote controlled robotics in terrorist and other highly dangerous operations, and monitoring of officers or suspects in officer assistance and high risk situations to allow on scene decision making and assistance based on video transmissions.[15] The Major County Sheriffs' Association noted a broadband application to be used in law enforcement is the video linking of helicopter to ground in following a suspect.[16]

2. Fire applications

Several of the fire and joint police/fire agencies addressed broadband applications from a fire department perspective. The Mesquite Fire Department, for example, identified personal area networks (PAN) applications that would wirelessly integrate a variety of lifesaving tools into the firefighter's suit and helmet. These include biometric and environmental sensors, 3D location, video and thermal imaging cameras, wireless microphones and earpieces, and voice recognition to allow complete hands-free and wire-free operation of all communications. High speed wireless data links will transmit this vital information to fire ground command centers, allowing them to constantly monitor the location and vital signs of all firefighters and help them navigate through smoke-filled burning buildings. These technologies could provide a critical link for quickly locating disoriented or downed firefighters before fatal injuries are sustained.[17]

The City of Tallahassee noted that, similar to others addressing fire applications, very large data and image files can be rapidly and wirelessly transferred within WLANs, to enable graphics such as maps, images and building blueprints to be downloaded into fire vehicle mobile computers as they leave the firehouse. WLAN technology will also enable fire ground command centers to employ full motion video for remote controlled robotics in intense fires, hazardous material and bomb disposal, and

[14] The County of Los Angeles Sheriff filing dated April 25, 2001
[15] The City of San Francisco Chief of Police filing dated May 7, 2001
[16] The Major County Sheriffs' Association (MCSA) filing dated April 20, 2001
[17] The City of Mesquite, Texas, Fire Chief filing dated April 10, 2001

dangerous search and rescue operations. This technology would allow real time transmission of video and imagery from aircraft to fire ground commanders.[18]

3. Specialized applications

The National Tactical Officers Association identified a number of broadband applications for specific public safety tactical units such as SWAT/tactical units and bomb squads. For SWAT/tactical units, solutions such as personal and vehicular area networks can wirelessly integrate a variety of existing and future devices to provide a safer environment for SWAT/tactical officers. These include image and video cameras and viewers, wireless long-range headsets, microphones, earpieces and voice recognition to allow complete hands free operations. SWAT/tactical unit applications include very large data and image files that can be rapidly and wirelessly transferred within a WLAN, enabling images/fingerprints of wanted or missing persons, video clips of robberies, maps and layouts of banks, schools or other high risk buildings to be downloaded into SWAT/tactical vehicle mobile computers as they are en route to a hostage/barricade situation or other high risk calls. This same technology also allows wireless uploads of videos, images and reports from a SWAT vehicle or on scene SWAT team to command posts and tactical operations centers set up at the scene. Broadband technology will enable command/tactical operations centers to employ full-motion video for remote controlled robotics in terrorist and other highly dangerous operations. It will also allow monitoring of officers or suspects in officer assistance and high risk situations to facilitate on scene decision making and assistance based on video transmissions. This technology would allow real time transmission video and imagery from surveillance positions to command/tactical operations centers. [19]

For bomb technicians, personal area networks (PAN) can wirelessly integrate a variety of lifesaving tools into the bomb technician's suit and helmet. These include biometric and environmental sensors, 3D location, vide and thermal imaging cameras, wireless microphones and earpieces, and voice recognition to allow complete hands-free and wire-free operation of all communications. High-speed wireless data links will transmit this vital information to bomb tactical operation centers, allowing them to constantly monitor the location and vital signs of bomb technicians and help them navigate through buildings. Very large data and image files can be rapidly and wirelessly transferred within WLANs, enabling graphics such as maps, images, building blueprints and pictures of improvised explosive devices to be downloaded into bomb technician vehicle mobile computers as they respond to a suspected device. WLAN technology will also enable bomb tactical operation centers to employ full motion video for remote controlled robotics in hazardous material and bomb disposal operations and to transmit wireless real time x-ray images of a suspected device. [20]

The Operation Respond Institute additionally identified broadband applications as critical for situations involving transportation of hazardous materials and railroad passenger rescue. Public safety dispatch centers have access to databases of major railroads, Amtrak and commuter rail organizations and nationwide motor carriers. In

[18] The City of Tallahassee, Florida, Police and Fire Departments filing dated April 11, 2001
[19] The National Tactical Officers Association filing dated March 27, 2001
[20] Id.

an event of an accident or incident involving transportation of hazardous materials or in railroad passenger rescue, the dispatch center would access the respective carrier's database to retrieve the relevant decision information needed at the accident scene by the public safety first responders (police, fire, medical, hazmat, rescue). The burgeoning wireless technology applications involving broadband transmission of integrated voice, graphics, video, overhead imagery and data can be envisaged in several ways: (1) Traditional databases that require referencing, detailed search or complete lists, tables or charts could be instantaneously transmitted and used by personnel at the scene. (2) Videos such as how to pry open a rail passenger door or panel, how to safely shut off electrical power will bring real know-how directly to the scene. (3) Transmission of complex imagery, maps and pictures will create substantial improvements in on-scene decision-making, and lets all involved responders from numerous agencies literally view the same image and data. To ensure that the systems are secure and reliable, and to protect sensitive and proprietary information, access must be limited to legitimate emergency responders on dedicated public safety frequencies. [21]

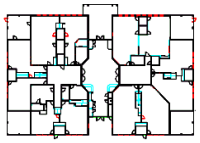
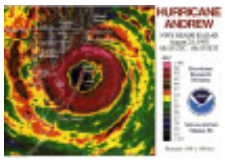
We believe that the above public safety broadband applications can be categorized into three distinct groups of solutions using emerging broadband technologies.

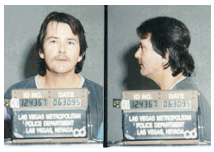
1. Personal Area Network/Vehicular Area Network (PAN/VAN)

These are Bluetooth-like applications designed specifically for public safety. They provide a wireless link between a variety of current and future devices to a belt worn or vehicular mobile radio. These include hands-free headsets, microphones, earpieces, palmtops, mobile data terminals, thermal imaging and video cameras, biometric and environmental sensors, 3D location devices. They would employ voice recognition to allow complete hands free operation, employing full duplex voice links between any localized team members. Many of these communications and peripheral devices will be integrated into specialized helmets and suits for firefighters, SWAT teams, bomb technicians, etc. PAN/VAN broadband systems provide very localized coverage around the public safety officer or vehicle, thereby providing very significant spectrum reuse of the same broadband channel throughout the agency's area of responsibility.

[21] Operation Respond Institute, Inc. filing dated May 18, 2001

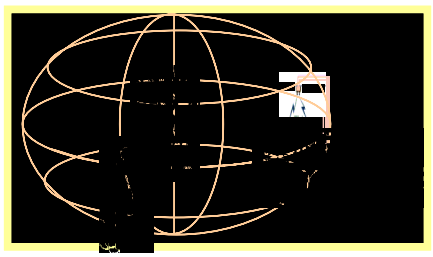
2. WLAN/Hot Spot




These provide automatic high-speed public safety Intranet file transfers to and from fixed "hot spot" locations using mission critical Wireless Local Area Networks (WLAN) technology. For example, as a 911 comes in, the dispatch CAD system automatically downloads critical information relative to the fire scene or incident into the vehicular mobile laptops. Very large data and image files will be rapidly and wirelessly transferred at the garage, firehouse or at any number of fixed locations throughout the public safety agency's area. Any of the above noted files, video clips, images, and even software upgrades, can be downloaded into a police, fire, EMS, SWAT, or other public safety vehicle mobile computer or data terminal as they pass by these hot spots, or visa-versa uploaded from the vehicle. With a 24-54 Mb/s raw data rate wireless link, somewhere in the range of 20-40 MB files can be downloaded in 30 seconds while the responders are assembling to leave for the scene. This system provides a high degree of spectrum reuse because the hot spot transmit and receive area is very geographically limited.

3. WLAN/On-Scene and Incident Command




Another mission critical application of WLAN technology is its use by ad-hoc fireground, incident or tactical command centers. These command centers are set up at the scene of a fire or incident, and require a very high capacity WLAN limited to the immediate incident scene area to provide wireless real time multimedia transfers within that localized area. As fire trucks, SWAT/tactical vehicles, command vehicles arrive at the scene, they deploy an ad-hoc WLAN erecting an antenna from a mobile access point in the command vehicle or one of the fire trucks. This enables the broadband multimedia, simultaneous voice, data and video wireless transfers between team members and the on-scene command center mobile computers, as noted by public safety users above. Similar to PAN/VAN and hot spot systems above, the on-scene/command scene

WLAN is localized to a limited incident area, thereby providing high spectrum efficiency and reuse.

## IV. Estimated Broadband Spectrum Amounts Needed

The main differences among broadband, wideband and narrowband technologies are the amount of data throughput achievable in a given amount of time and coverage. The broader the bandwidth, the greater the throughput and the shorter the delay in receiving the information. Accessing sufficient bandwidth for broadband communications also generally requires spectrum in higher bands. This in turn translates to on-scene instead of wide area coverage.

Wired high speed computer networks have capacities of approximately 10 Mbps. To equal or better that performance, wireless networks must have sufficient bandwidth to support similar data rates, overcome propagation anomalies not faced in a wired network, and to support error detection and correction. As noted, Public safety users also would like to help keep cost down by leveraging the chip technology developments used for consumer broadband products, such as those built on the HiperLAn2 or IEEE 802.11 family of standards. Accordingly, we believe channels of 20-25 MHz are appropriate to meet these requirements.

Broadband systems are designed for very localized coverage areas, such as the PAN/VAN networks, hot spot locations and on-scene command networks, having ranges of 1 to about 1000 meters. Narrowband and emerging wideband systems, on the other hand, are designed for wide area coverage requirements, providing regional, statewide and even multi-state systems coverage. As a result of their very localized use, even though broadband technology requires a relatively large channel, it is spectrally efficient because the same channels can be reused many times at multiple locations throughout a given city.

Motorola has developed analysis to quantify the amount of broadband spectrum that public safety needs for the type of broadband applications that public safety associations and agencies are describing in their filings. Based on information provided by public safety users and on our experience in serving the public safety market, we defined a typical on-scene scenario and applied engineering analysis to quantify the amount of spectrum required for that on-scene location. The scenario we have used is that of a large building fire. While the specific types of responders would be different for each type scenario, the fire scenario is representative of the overall communications capacity required. Therefore, the conclusions are applicable as well to other scenarios such as swat operations.

### Large building fire scenario

The incident scene is a 100 + meter radius area. Upon leaving the fire station, responders will down load data on building, floor plans, utility plans, hydrant locations, hazardous material, etc. into their on-board mobile computer from a fixed broadband hot spot.

Numerous small teams of fire fighters must be deployed to battle fire inside the building, battle the fire on each building exposure, and to prevent the fire from spreading to adjacent buildings. Each team of fire fighters needs to communicate to each other, to support staff manning the fire apparatus, and to their immediate command staff. Each fire fighter should have telemetry providing biometric status back to the command post. The on-scene commander needs input from each team. They need to have video from each side of building and from each team inside building.

Fire investigators are on scene to determine where the fire started and to observe crowd if arson is suspected. Video would be used to document progress of fire and record crowd for later analysis. At least one ambulance and paramedic team is on-scene to handle any accidents and injuries. Police are on-scene to provide crowd control and divert traffic around the building. Police need to make sure that fire apparatus can get to proper locations.

Surveillance devices include two robotic devices used to investigate the interior of building before fire fighters enter the building. Wireless video is needed to control robotic device, obtain telemetry from sensors, video or thermal images from cameras. Also, a fixed device would be used on each side of the fire relaying video back to an on-scene command center.

Estimated number of public safety on-scene is 45+ personnel, as follows:

Must deploy enough fire fighters to handle:
- all 4 sides of building, both fire fighting and preventing fire from spreading to adjacent buildings (15-20)
- multiple 2-3 man teams to enter building (10)
- command/support for each side of fire (4)
- overall fire scene command/support (2)
- fire investigators (2)

Ambulance and paramedics on-scene
- minimum of 1 ambulance with 2 paramedic

Police (6)
- initially for crowd & traffic control
- later for investigation
- surveillance helicopter

Most on-scene communications are handled via broadband links between nomadic devices worn by each person on scene. At least one WLAN (20 MHz bandwidth) and several localized Personal Area Networks (PANs) (20 MHz bandwidth) are formed to handle communications between small teams. Many functions that were simplex and intermittent can now be full duplex and continuous. Because these transmissions are limited to a very localized area, there is a high degree of spectrum reuse within a system, making this broadband system spectrally efficient.

We note that a combination of existing, wide-area, narrowband simplex or narrowband repeater/trunking and wideband data channels will continue to be used for additional communications with the jurisdiction's dispatch center and other wide-area operations. However, these channels will no longer be the only channels available to on-scene communications.

Voice - All personnel (100%) on scene are using voice communications. Users are no longer limited to short dispatch-type conversation totaling a little over 3 minutes per user. Conversations could be full duplex, multi-user group calls. Voice traffic is not a major loading factor. Amount of voice traffic per user can be more than doubled. Data rate can be increased to improve quality and/or reliability of signal. Multiple, simultaneous conversations can be handled on the broadband channels. Localized use of low power, broadband channels only ties up those channels for a small radius around the incident scene, and those channels could be re-used at another incident scene less than a mile away.

Telemetry/Status communications - Status updates are short data packets. Telemetry is short packets of data that can be sent almost continuously. There is a significant increase in the amount and type of status/telemetry information that can be sent, when compared to narrowband channels. External sensors for heart rate, respiratory rate, body temperate, external temperature, etc would be tied to the broadband nomadic device. All personnel on-scene (100%) would be equipped with telemetry and monitored at on scene command post.

Monitoring: continuous telemetry from fixed and/or robotic devices - Set up monitoring location on each side of fire (may be mounted on fire apparatus). Or, send robotic devices into building. Or, fire fighters carry devices into building. Each piece of fire apparatus on scene could be monitored from an on-scene command post.

Surveillance: near-continuous telemetry and video from fixed and/or robotic devices - Set up surveillance location on each side of fire (may be mounted on fire apparatus). Or, send robotic devices into building. Broadband provides high quality video images and/or thermal images. There is a remote control link back to surveillance device.

Database access, Intranet access, File Transfers – Command staff, support staff, investigators, police, paramedics will use this service to download and upload files, images, video clips, and plans. Broadband provides large amounts of data with near instantaneous access.

Personal video – Most personnel on scene (80%) are equipped with personal video device tied to their broadband nomadic device. Devices could be mounted to a responder's helmet. Likely use is lower resolution video (<10 frames per second) and limited image size (1/4 frame). Deployment may also include thermal imaging. Broadband provides the ability to send images back to on-scene command post on demand.

Full video - Command staff, support staff, investigators (20% of those on scene) will use this service, including high resolution video (30 frames per second) and full image size (full frame) to obtain high quality images (at least VHS-tape quality). Broadband

provides high quality record for later analysis. Video clips could be sent back to command center for immediate use and/or analysis.

Multi-media conference - Command staff, support staff, investigators (20% of those on scene) will use this service. Broadband provides live, multi-user video and audio conference between on- scene staff and command center.

Summary of Estimated Spectrum Requirements

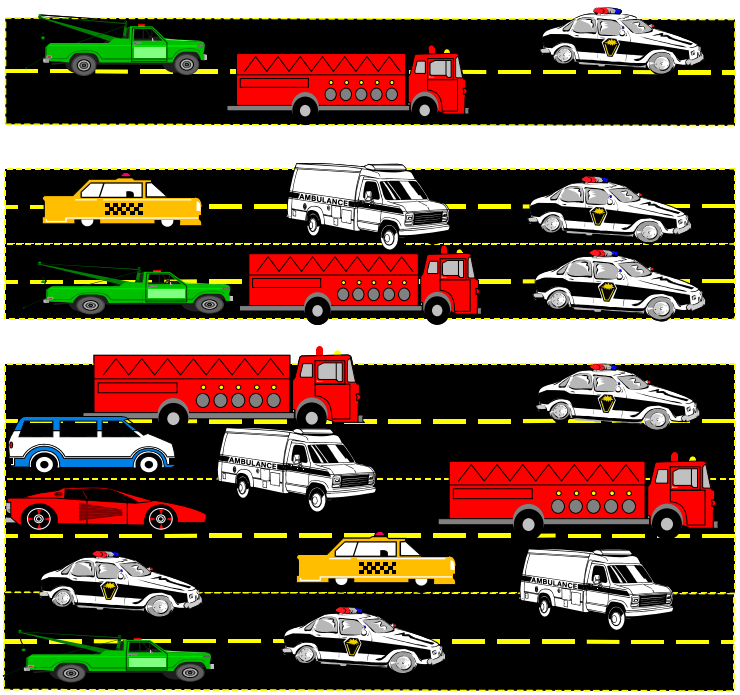
| | |
|---|---|
| Voice | 0.827 MHz |
| Monitoring/Message | 2.246 MHz |
| Telemetry/Status | 2.042 MHz |
| Database access | 2.164 MHz |
| Intranet access | 0.751 MHz |
| File Transfer | 5.786 MHz |
| Surveillance | 14.583 MHz |
| Personal Video | 3.008 MHz |
| Full Motion Video | 10.000 MHz |
| Multi-media Conference | 8.813 MHz |
| | --- |
| Total | 50.2 MHz |

## V. Distinction of 4.9 GHz Broadband and 746 MHz Wideband and Narrowband

As depicted in the illustration below, the need for different bandwidths and throughput is analogous to that of highways. Public safety users have distinctly different communications needs, especially with the introduction of emerging advanced technologies. Traditional voice and low speed data systems are designed for narrow channel widths, 25 kHz and less. (These are the basic two lane highways). The data throughput rate is generally less than 100 kbps in a 25 kHz channel, and together with the propagation characteristics in spectrum below 2 GHz, this technology fits best for wide area systems. Increasing the traffic flow requires a wider road. Wideband systems such as the 50 – 150 kHz channels implemented in 746 MHz band allow significant increases in data throughput, generally at an order of magnitude between 100 and 1,000 kbps, and like narrowband, supports wide area operations. However, to allow the amount of data throughput that is needed for the public safety on-scene applications noted herein, much greater throughputs and significantly broader channels are required.

As addressed previously in Section IV of this paper, the requirements delineated by the public safety community lead us to recommend that the Commission adopt channel widths of 20-25 MHz for 4.9 GHz broadband systems. Broadband systems are designed for very localized coverage areas, such as on-scene and hot spot coverage, having ranges of 1 to about 1000 meters. Such limited coverage area allows for very intensive but localized use of broadband spectrum, thereby creating a high level of spectral efficiency with a high degree of reuse possible throughout a given city. Because of propagation characteristics and spectrum availability, spectrum above 2 GHz, is best suited for broadband operation. Further, public safety's need to minimize costs by leveraging 5GHz UNII consumer chip technology development makes 4.9 GHz the right spectrum.

Illustration: Multiple Public Safety Customer Needs




**Narrow Band**

**Voice, Low Speed Data**
**Wide Area Coverage**
**10-100 kbps**

**Wide Band**

**Higher Speed Data, Images**

**Wide Area Coverage**

**100-1000 kbps**

**Broad Band**

**Integrated Voice, High Speed Data, Full Motion Color Video**

**On Scene and Hotspot Coverage**

**1-100 Mbps**

In addition to the on-scene vs. wide area coverage difference between broadband and narrowband/wideband, broadband is designed as multimedia technology, allowing multiple simultaneous transactions, including voice, high speed data and full motion video. We will look at the distinctions separately:

- Unlike traditional narrowband or new wideband push to talk simplex voice, voice on WLAN/PAN broadband using TDD can do duplex voice circuits or multi-user conference call, especially among local PANs/VANs, producing near-toll voice quality because of the higher data rate (about twice the narrowband rate).

- Status reporting in narrowband currently uses a manual button press for short pre-programmed status message and emergency alerts, or could be handled as data messaging through sensors tied to external devices. Broadband status/telemetry functions, such as heart rate, respiration, body temperature, etc., would be tied directly into body worn nomadic devices on WLAN/PAN, allowing continuous reporting on 100% of the users.

- Data and images over a 150 kHz wideband channels currently has a 384 kbps raw data rate over a wide area. Using Scalable Advanced Modulation proposed by Motorola for use in the 746 MHz band, a throughput rate of 690 kbps is achievable in a 150 kHz wideband channel. In comparison, broadband allows for the downloading and uploading of very large data files and images (maps, diagrams, pictures) at a significantly greater rate at fixed sites called hot spots.

- Wideband can handle compressed, lower level of detail video that is approximately ¼ frame picture size at the above data and images rates. Because of the enormous data rate needed for real time full motion video, only broadband channels have the capacity to transmit high detail full motion video in real-time. MPEG-2 video rates are 1.5 Mbps in broadband channels.

Given the bandwidth requirements of the broadband technology, there simply is not enough capacity in the 746 MHz public safety band to allow broadband use. Secondly, the propagation characteristics of the 746 MHz band are best suited for wide area systems, as compared to broadband uses that have a very localized area. Without the 4.9 GHz broadband spectrum allocation, public safety users would not have the capacity to implement the types of on-scene communications described identified in the comments in the record of this proceeding. Further, without this allocation, users would need to dedicate spectrum that could be used for wide area operations to support an on-scene requirement. That means that usage at a single incident could prohibit use throughout the jurisdiction. In contrast, allocating 50 MHz of spectrum at 4.9 GHz to public safety provides spectrum with sufficient capacity and a high degree of re-use and maintains existing bands including 746 MHz to support wide area requirements.

## VI. Impact of Navy Systems

The actual usability of the 4.9 GHz band is determined in part by the nature of adjacent Federal operations. The US Navy has Cooperative Engagement Capability (CEC) systems in that adjacent spectrum. The reallocation of the 4.94-4.99 GHz band still leaves several hundred megahertz of spectrum in which these Federal systems operate and that spectrum is directly adjacent to the 4.94 GHz band. CEC systems are deployed primarily in relatively limited areas in the US, which are specifically designated CEC system training areas and/or T&D test locations. However, they are sometimes also used outside these training areas.

First, public safety communications requirements in this band involve relatively low power levels for on-scene and hot-spot operations. Therefore, we do not project any interference to Federal systems from public safety use. The key question is the extent of impact Federal operations will have on public safety use of the band.

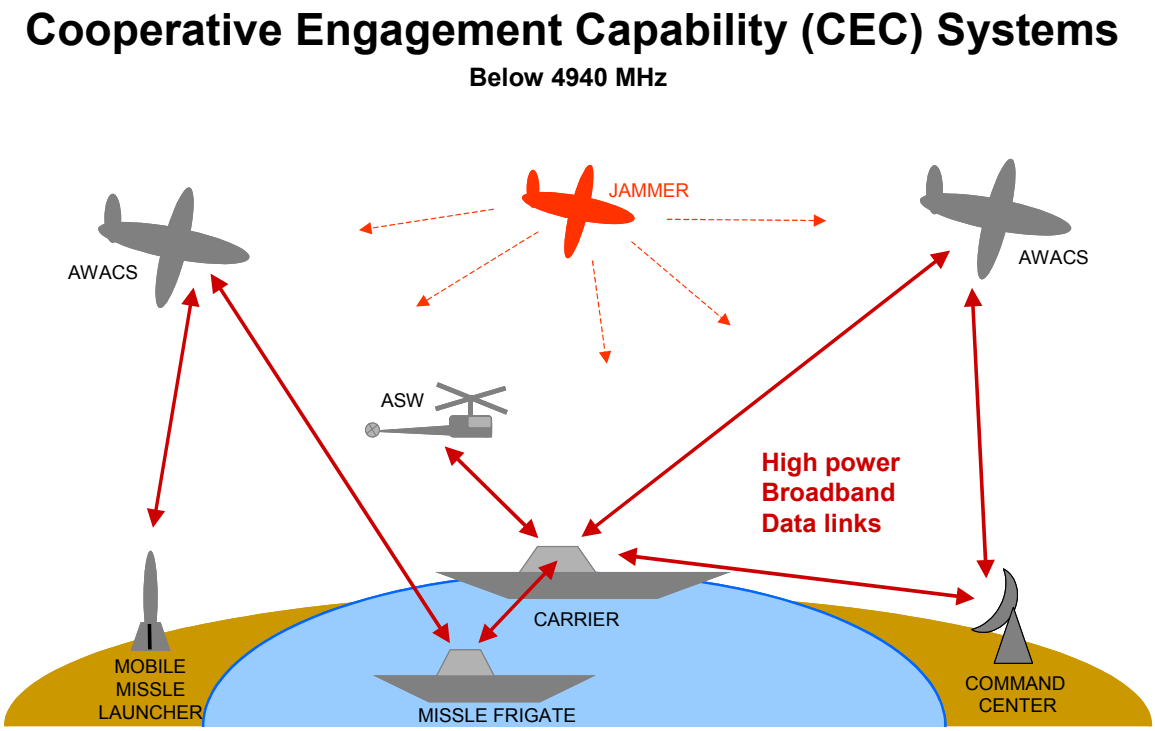
According to letters from NTIA to FCC placed in the record of this proceeding, Navy operations outside the training areas would use a 50 MHz guardband below 4940 MHz and more moderate power levels. Based on our analysis CEC operations outside the training areas would provide minimal impact on public safety use of the 4.94-4.99 GHz band. There are still some areas of the country where CEC operations within the training areas may affect public safety operations outside those training areas. Public safety users and Federal users will need to work together to ensure the maximum possible use of the reallocated spectrum in the geography surrounding these training areas. We believe that public safety is in a far better position to perform such coordination, to ensure that both Federal and non-Federal use of the spectrum is maximized, than if the spectrum were reallocated to general consumer uses. While military and public safety operations are by no means exactly the same, these users do share a much closer common appreciation of

mission critical communications requirements. Second, it appears that public safety and the military also share a closer appreciation of the operational need to protect sensitive information appropriately. We believe they each have personnel who are, or could be, qualified under the appropriate clearances. Finally, effective use of the band as a general consumer allocation would likely require much greater accommodation by the military, given that consumer use, by its very nature, is much less controlled than public safety use.

The remainder of this section addresses the potential impact of the Navy CEC systems from a technical perspective. Given that these are military systems, our analysis is limited to the information that has been made available and operational assumptions made from that information.

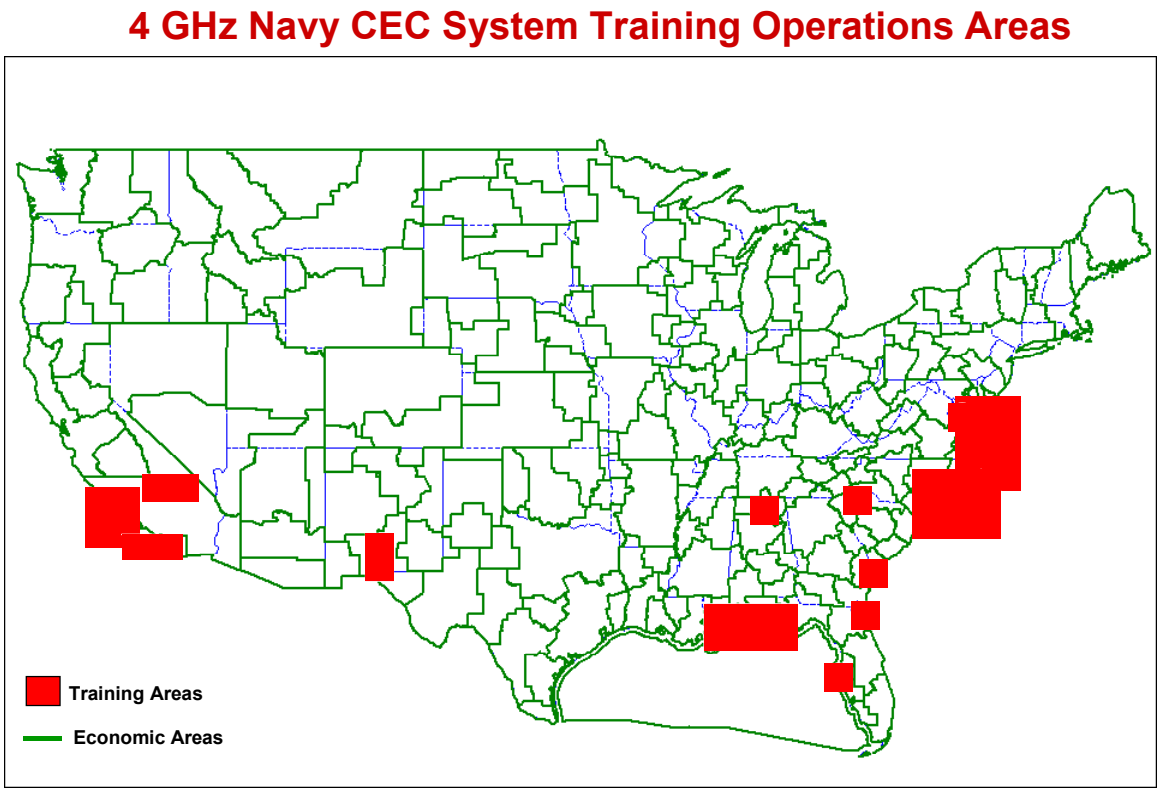
The NTIA/DoD/Navy have designated operations within the training areas to be used for full power (up to 630 kW) and full bandwidth (up to 4940 MHz) operations for ground based, ship borne, or air borne (up to 30,000 ft) operations.

The following illustrates how CEC uses high power, broadband, data links to share information among multiple users on ground, ships and aircraft.



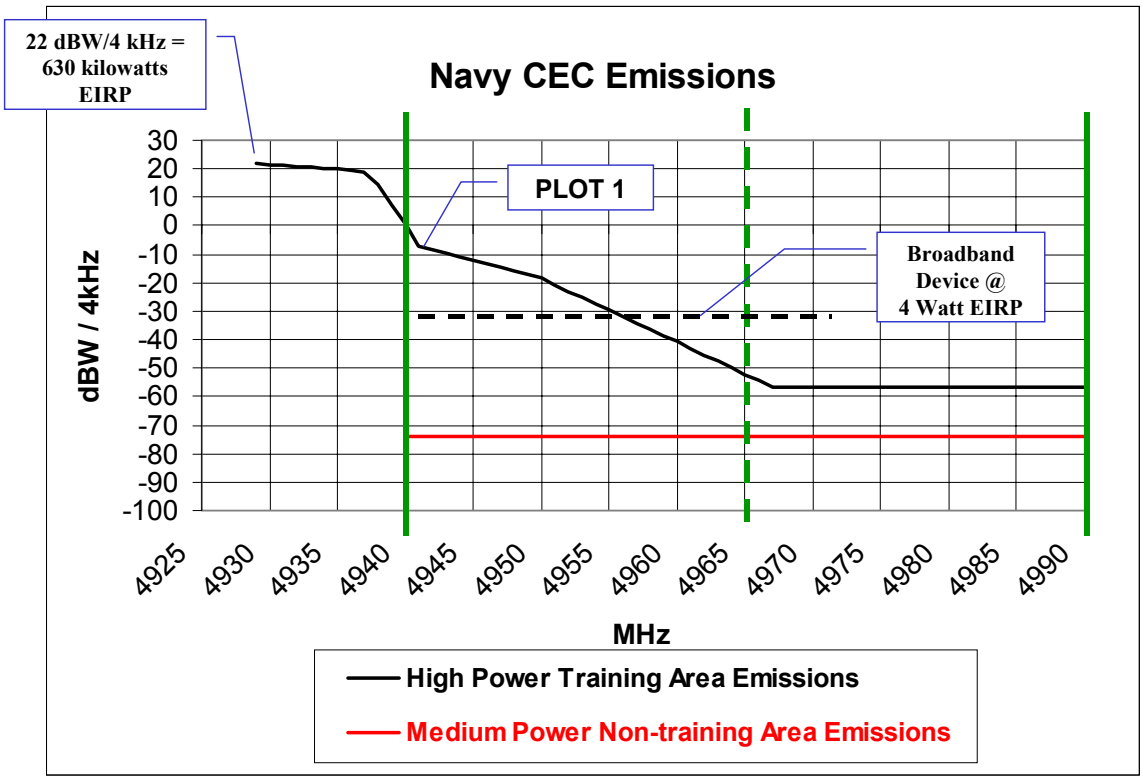

The following map identifies the CEC system training areas and/or T&D test locations. The Atlantic, Gulf, and Pacific training areas extend 30 nautical miles inland from coast and include operation in US coastal waters off of the designated coastal areas. We estimated a 30 mile radius around the locations where R&D testing will be conducted, since no radius for operations was provided. Note that aircraft at 30,000 ft and operating a directional antenna at 630 kW, with just free space loss, could present a signal level of –100 dBm (~noise floor of 20 MHz bandwidth receiver) to devices located as far away as

250 miles. However, this distance is dependent on the direction of the airborne antenna relative to the specific site of operation in the 4.94-4.99 GHz band. Also, if the path from the plane to the public safety site included some attenuation beyond that of free space, the distance would be reduced. The resulting impact could also vary depending on the duty cycle of the Navy transmissions.



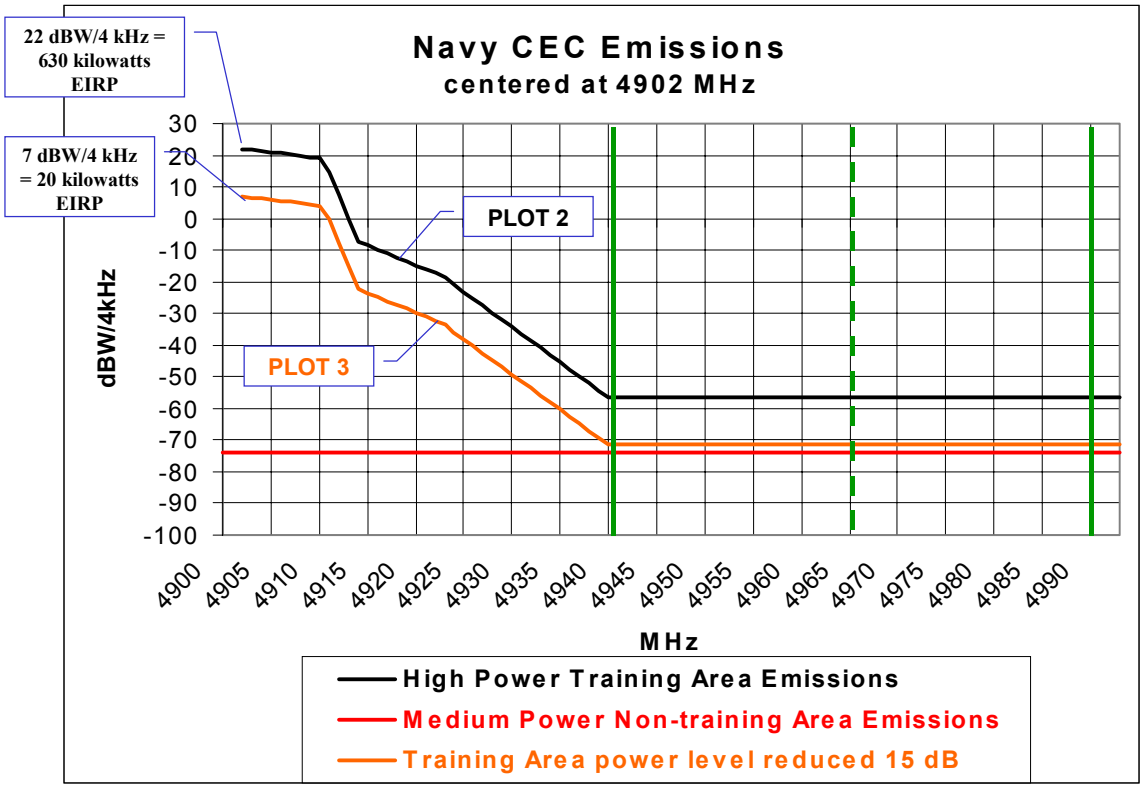

Our analysis assumes 20 MHz wide channels in 4940-4990 MHz, and protocol and device characteristics similar to HiperLAN2. To gain economies of scale, public safety noted that they would like to use devices that meet their mission critical requirements yet leverage the standards based broadband technologies being developed for the adjacent 5 GHz unlicensed bands.

The following chart shows the emissions from the Navy CEC system.




Plot 1 in the above chart shows the CEC system training area emission mask at high power and centered at the highest operating frequency (4929 MHz). CEC system can radiate a directional signal up to 630 kW EIRP over ~25 MHz bandwidth (-23 dB points). Emission mask reaches minimum –80 dBc out-of-band emission level at 4967 MHz (38 MHz from center).

There is no "guard band" within the government spectrum, in the traditional sense. If there were a guard band, we would expect to see –80 dBc level occur below 4940 MHz. By dividing the 4940-4990 MHz band in half, the CEC emission mask occupies all of lower half of the band (0 dBW/4kHz at 4940 MHz down to less than -50 dBW/4kHz at 4965 MHz). For over ¼ of the 4940-4990 MHz band, CEC system high power emissions could be higher than broadband nomadic device EIRP (1 watt w/ 6 dBi antenna = 4 watts EIRP). In the upper half of the band, operating with CEC signal level at –58 dBW/4kHz inside training areas, would be usable with preclusion zones around the training areas (up to 15 miles outside training areas).




Plot 2 in the above graph shows the CEC system emission mask at high power and centered at 4902 MHz, creating a guard band within the CEC spectrum. CEC emission mask plot has been moved such that the knee of the plot, at –58 dBW/4kHz, now occurs at 4940 MHz (~38 MHz from center). The CEC system would still be operating within the training area, at or below 4902 MHz center, and radiating a directional signal up to 630 kW EIRP. With the resulting CEC signal level at –58 dBW/4kHz inside training areas within the 4940-4990 MHz band, the spectrum would be usable, particularly with preclusion zones around the training areas (up to 15 miles outside training areas).

Plot 3 shows the CEC system emission mask, also centered at 4902 MHz, moved down by 15 dB when the CEC system is operated at medium power. The CEC system would be radiating a directional signal up to 20 kW EIRP. With the resulting CEC signal level at –72 dBW/4kHz inside training areas within the 4940-4990 MHz band, there would be negligible interference to 20 MHz broadband receivers, operating up to the borders of the training areas.

Our conclusions are:

1) We support the NTIA/DoD/Navy commitment that CEC operations outside the designated training areas operate at a medium power level and not use the top 50 MHz of spectrum (assume 4890-4940 MHz). This results in a level across the band of about –72 dBW/4kHz. We agree that at this level, there would be negligible interference to broadband receivers operating in the 4940-4990 MHz band.

2) In some geographic areas, public safety users and Federal users will need to work together to minimize the impact of CEC systems operating within the training areas. Otherwise, the full allocation will not be available in those areas.

3) Should interference problems develop in limited geographical areas, there are a number of options which might be explored between public safety and Federal users, which take account of the operational requirements of both sets of users in the local area.

The following chart summarizes the range of actions and resultant impacts that might be explored at the appropriate time between public safety and Federal users.

Possible Scenarios

| Type of CEC Operation | | Precision Zone Around Training Area if CEC Airborne | Preclusion Zone Around Training Are if CEC Land or Ship Based |
|---|---|---|---|
| Non-Training Areas: Top 50 MHz not Used; Medium Power on all CEC Channels | | Negligible | Negligible |
| Training Areas: Top CEC Channel Not used; Medium Power on Other CEC Channels | Plot 3 | Negligible | Negligible |
| Training Areas: Top CEC Channel Not used; Medium Power on Highest CEC Channel: High Power on Other CEC Channels | | Negligible[22] | Negligible |
| Training Areas: Top CEC Channel Not Used; Full Power on Other CEC Channels | Plot 2 | 10-15 Miles | 5-10 Miles |
| Training Areas: Top CEC Channel used, Full Power on All CEC Channels | Plot 1 | 125-250 Miles[23] | 25-50 Miles |

[22] Assumes no airborne operations directly above the public safety user.
[23] This is a worst case scenario based upon certain assumptions that may occur only rarely.

## VII. Preliminary power limits and channel plan

The public safety community has indicated its need for broadband spectrum in the 4.9 GHz band to meet its projected mission critical applications for broadband communications in the 21st Century. As detailed in the above sections, public safety users indicated three proposed requirements for broadband technology and wireless coverage: PAN/VAN networks, WLAN hot spot locations, and WLAN on-scene/incident command communications.

Because of the standards based consumer broadband HiperLAN2 and IEEE802.11 family of technologies that are being developed for the adjacent 5 GHz unlicensed bands, computer chip technology and applications providers will be able to achieve greater economies of scale with the 4.9 GHz products, thereby lowering costs to public safety. To leverage such opportunities, the technology, architecture and rules between the adjacent unlicensed bands and the public safety allocated bands should have similar designs, yet be adjusted as needed to meet the mission critical requirements of public safety users.

Maximum Power Limits

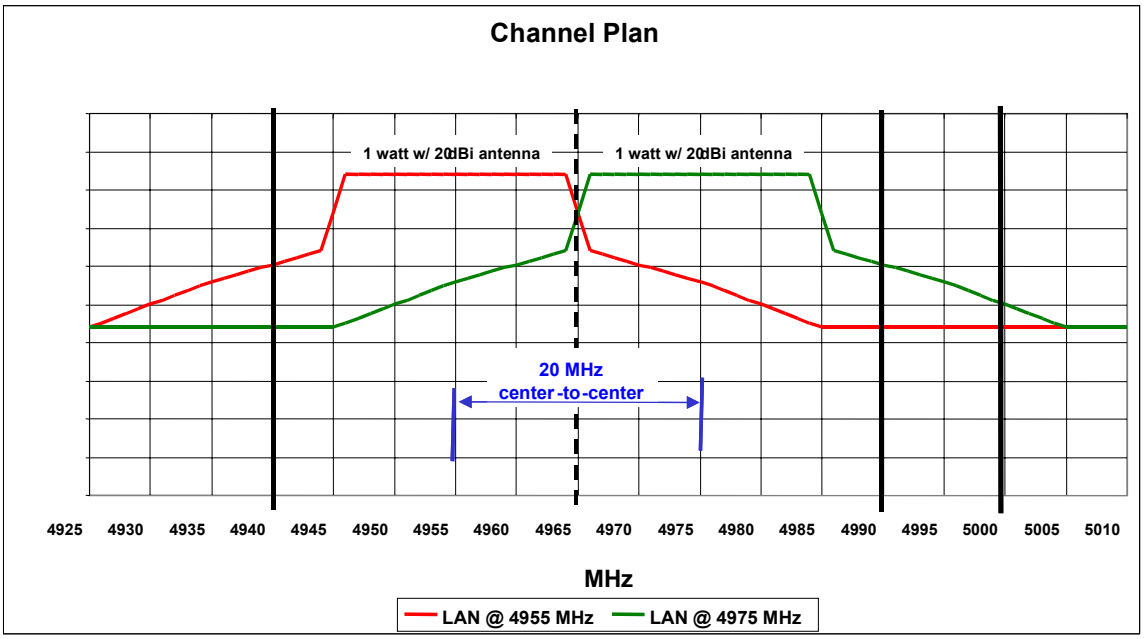
To meet the in building coverage and reliability requirements defined by public safety, Motorola recommends the following power limits be adopted:

1Watt maximum transmitter power; 20 dB maximum antenna gain.

Note that this is the level we believe is needed for on-scene broadband LAN operations. PAN/VAN uses may actually operate at lower levels, e.g., 10mW maximum transmitter power; 6 dB maximum antenna gain. However, we believe Commission rules should specify the maximum power and antenna gain needed for reliable on-scene or hot spot coverage for both channels. Public safety users may chose to operate one of those channels at powers lower than the maximum, consistent with personal area networks (PANS). The choice would be up to the public safety users to determine how best to deploy the channels consistent with this overall power limit. In all likelihood, different situations may require a different mix of these operations and the rules should provide the flexibility for public safety users to accommodate all possible situations to the extent possible.

Channel Plan:

We recommend that the Commission implement two 20-25 MHz channels in 4940-4990 MHz band, consistent with the public safety user's interest in leveraging commercial technology from adjacent 5 GHz bands. The following chart depicts one approach where the centers are 20 MHz apart. This separation could be increased to 25 MHz, dependent upon interference issues with spectrum below 4940 MHz and above 4990 MHz.

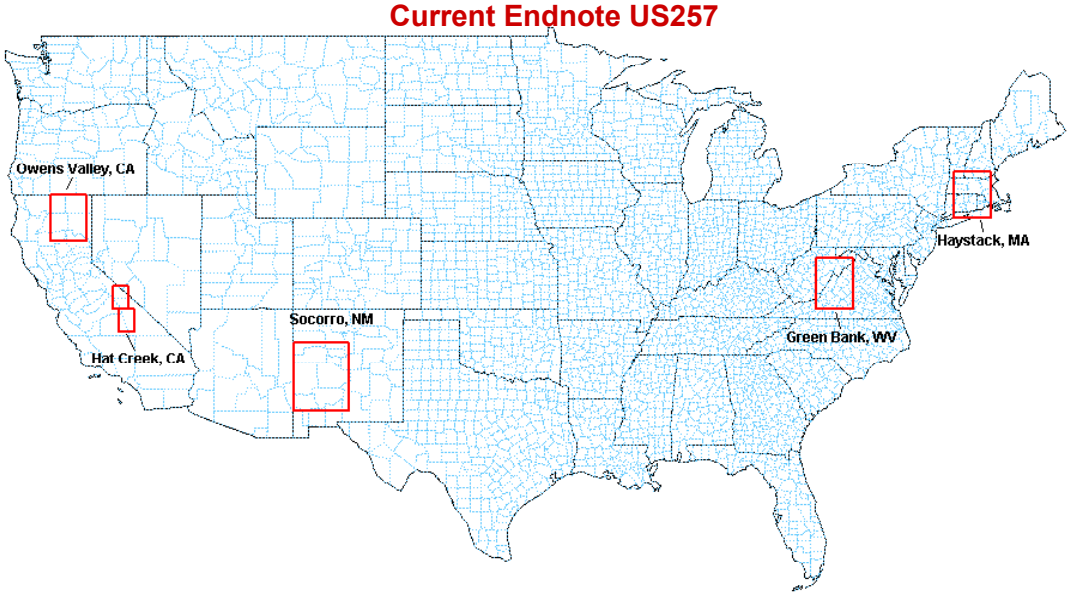



## VIII. Protection of Radio Astronomy Sites

As shown in the following two site maps, there are currently fewer than fifteen radio astronomy sites above 4990 MHz in the continental US, under current endnote US257 and proposed endnote US311, which must be protected from interference. As the maps clearly indicate, these sites represent a very small percentage of the US geography, and most are not located within major metropolitan and heavily populated areas. Motorola recommends that public safety protect these radio astronomy sites through coordination zones when implementing broadband systems. The requirement to coordinate would be triggered for public safety use within 50 miles of the radio astronomy sites. This will allow public safety agencies to maximize their use of broadband systems in the most populated areas without impacting radio astronomy operations.

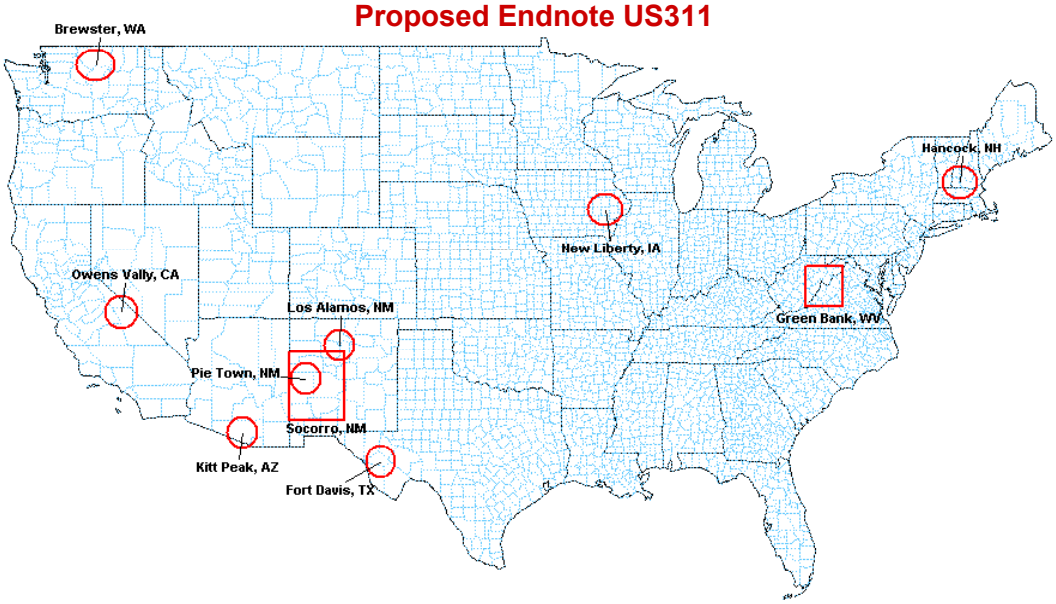
## Above 4990 MHz

**Protected Radio Astronomy Sites**
**Current Endnote US257**




## Above 4990 MHz

**Radio Astronomy Sites**
**Proposed Endnote US311**



## IX. Conclusion

The public safety community has long expressed its need for additional spectrum to accommodate newly emerging advanced broadband technology, as noted in the PSWAC Report of 1996 and most recently as evidenced by the over 100 documented filings by major public safety associations and individual agencies on WT Docket No. 00-32. For the same reasons that public safety users require dedicated spectrum for narrowband and wideband systems, the Commission should allocate the 50 MHz of spectrum in the 4940-4990 MHz band to public safety for mission critical broadband applications and adopt service rules that consider public safety user requirements.

As noted by the public safety comments filed, the 746 MHz wideband allocation does not have the capacity, nor does it meet the propagation characteristics best suited for very high speed, high capacity data, short distance broadband transmissions. Public safety users pointed out that 4.9 GHz is a much better fit for their proposed broadband mission critical on-site applications, leaving 746 MHz band capacity for wide area operations. These applications, categorized into three distinct broadband solutions (PAN/VAN networks, WLAN hot spot locations, and WLAN on-scene/incident command communications), require a minimum of 50 MHz in order for public safety to implement these planned applications.

Our analysis of the Navy CEC Systems in operation below 4940 MHz shows that there is significant geography in which public safety systems can be deployed. We also believe subsequent discussions between public safety and Federal users may be able to expand those areas further and have provided some technical analysis that may help with those discussions.

Given the relatively low number of radio astronomy sites operating above 4990 MHz, Motorola recommends protecting these sites through the use of coordination. Such coordination could be triggered whenever public safety use would be within 50 miles from the protected radio astronomy site. This will maximize the use a public safety broadband systems in the populated areas of the country, while protecting radio astronomy from interference.

Motorola recommends that the Commission rules define two 20-25 MHz channels in 4940 – 4990 MHz band, with a maximum transmitter power of 1 watt and maximum antenna gain of 20 dB. This approach is consistent with the public safety community's interest in leveraging consumer semiconductor development to help lower costs and its need for reliable on-scene in building coverage.

APPENDIX A

**Supporting Comments and Filings To FCC**
**Public Safety Request for Allocation of 4.9 GHz**

**Public Safety Agencies (96)**

***Major Cities Chiefs (34)***

Atlanta Police, GA
Baltimore County Police, MD
Buffalo Police, NY
Charlotte-Mecklenburg Police, NC
Chicago Police, IL
Cleveland Police, OH
Columbus Police, OH
Dallas Police, TX
Denver Police, CO
Detroit, MI
El Paso Police, TX
Fort Worth Police, TX
Indianapolis Police and Fire, IN
Kansa City Police, MO
Las Vegas Metropolitan Police, NV
Los Angeles County Sheriff, CA
Los Angeles Police, CA
Memphis Police, TN
Metro-Dade Police, FL
Minneapolis Police, MN
Nashville Police, TN
Nassau County Police, NY
Newark Police, NJ
Oklahoma City Police, OK
Philadelphia Police, PA
Phoenix Police, AZ
Pittsburgh Police Bureau, PA
Portland Police, OR
Salt Lake City Police, UT
San Diego Police, CA
San Francisco Police, CA
Seattle Police, WA
Tulsa Police, OK
Virginia Beach Police, VA

***Other Public Safety (62)***

Addison Fire, TX
Arlington, City of, TX
Austin Police, TX
Beech Grove Fire, IN
Beech Grove Police, IN
Bexar County Sheriff, TX
Brigham Young University Police, UT

Caddo Parish Communications District No. One, LA
Champaign, City of, IL
Chattanooga Fire, TN
Chattanooga Police, TN
Chesapeake Fire, VA
Chicago Office of Emergency Communications, IL
Contra Costa County Sheriff, CA
Cunningham Fire Protection District, CO
Dallas-Fort Worth Airport Dept. of Public Safety
De Kalb County, GA
Douglas County Sheriff's Office, CO
Dyer Police, TN
Edmond's Central Communications, OK
Erlanger Health Systems Telecom. Dept, TN
Florence County Department of Emergency, SC
Forrest County, MS
Fort Lauderdale, FL
Gainesville Police, FL
Geauga County Dept. of Emergency Services, OH
Grove City Police, OH
Hall Park Police, OK
Hamilton County 911, OH
Homecroft Police, IN
Kenneth City Police, FL
King County Sheriff, WA
Lawrence Fire Department, TX
Lawrence Police Department. TX
Maitland Police and Fire, FL
Mesquite Fire, TX
Morristown Police, TN
North Carolina State Highway Patrol
Oklahoma Sheriff's Office, OK
Oldsmar Fire, FL
Palm Harbor Fire, FL
Parker Fire Protection District, CO
Pike Township Fire Department, IN
Pinellas Co. Emergency Communications, FL
Pinellas County Sheriff's Office, FL
Plano Police, TX
Rockland County, NY
Salt Lake City Dept. of Airports, UT
San Antonio Police, TX
San Diego County Sheriff, CA
Seminole Fire Rescue, FL
South Nyack Grand View Police, NY
South Pasadena Public Safety, FL
Southport Police, IN
Springville Police, UT
Tallahasee Police and Fire, FL

Terrell Fire, TX
Texas City Fire, TX
Tri-Community Volunteer Fire Department, TN
Tulsa, City of, OK
Virginia Beach Dept. of Comm. & Info.Tech, VA
Waco Police and Fire, TX

**Associations and Industry (13)**

Association of Public Safety Communication Officials International (APCO)
Federal Law Enforcement Wireless Users Group (FLEWUG)
Hispanic American Police Command Officers Association (HAPCOA)
International Association of Chiefs of Police (IACP)
Major Cities Chiefs Association (MCC).
Major County Sheriffs' Association (MCSA)
Motorola Inc.
National Association of Black Law Enforcement Executives (NOBLE)
National Public Safety Telecommunications Council (NPSTC)
National Tactical Officers Association (NTOA)
Operation Respond Institute, Inc.
Public Safety Wireless Network (PSWN)
South Carolina Chapter of MTUG